

WHAT IS CLAIMED IS:

- 1 1. A multilayered torsional hinged resonant pivoting device comprising:
  - 2 a hinge layer defining a support structure and an attaching member, said support structure
  - 3 for pivotally supporting said attaching member along a first axis of rotation by a pair of torsional
  - 4 hinges, and said attaching member having a front side and a back side;
  - 5 a front layer having a functional surface portion, and a back portion, said back portion of
  - 6 said front layer mounted to said front side of said attaching member and said front layer having a
  - 7 known mass moment about said first axis; and
  - 8 a back layer mounted on said back side of said attaching member and having a mass
  - 9 moment substantially equal to and opposite said known mass moment of said front layer, such
  - 10 that the center of mass of the combined front and back layers is substantially coplanar with the
  - 11 first axis of rotation and the moment of inertia of said multilayered torsional hinged device is
  - 12 substantially centered on said first axis of rotation.
- 1 2. The multilayered device of claim 1 wherein said hinge layer comprises an anchor
- 2 member connected to said attaching member along said first axis by said first pair of torsional
- 3 hinges.
- 1 3. The multilayered device of claim 2 wherein said anchor member is a support frame.
- 1 4. The multilayered device of claim 2 wherein said anchor member is a pair of anchor pads.
- 1 5. The multilayered device of claim 1 wherein said support structure of said hinge layer
- 2 comprises a gimbal portion connected to said attaching member along said first axis by said pair

3 of torsional hinges and an anchor member pivotally supporting said gimbal portion by a second  
4 pair of torsional hinges along a second axis substantially orthogonal to said first axis.

1 6. The multilayered device of claim 5 wherein said anchor member is a support frame.

1 7. The multilayered device of claim 5 wherein said anchor member is a pair of anchor pads.

1 8. The multilayered device of claim 1 wherein said back layer is a permanent magnet.

1 9. The multilayered device of claim 8 and further comprising a magnetic coil connected to  
2 an alternating voltage having a frequency substantially equal to a selected sweep frequency of  
3 said pivoting device and wherein said magnetic coil and said permanent magnet interact to create  
4 pivotal movement of said functional surface at said resonant frequency.

1 10. The multilayered device of claim 9 wherein said selected sweep frequency is  
2 substantially equal, to the resonant pivoting frequency of said device about said first axis.

1 11. The multilayered device of claim 1 wherein said back layer has a size and shape  
2 substantially matching said size and shape of said attaching member.

1 12. The multilayered device of claim 11 and further comprising piezoelectric material  
2 bonded to said support structure of said hinge layer to create resonant pivoting of said device.

1 13. The multilayered device of claim 1 wherein said hinge layer is made from single crystal  
2 silicon.

1 14. The multilayered device of claim 13 wherein said front layer is made from single crystal  
2 silicon.

- 1 15. The multilayered device of claim 5 wherein said back layer is a permanent magnet.
- 1 16. The multilayered device of claim 15 and further comprising a magnetic coil connected to  
2 an alternating voltage having a frequency equal to a selected sweep frequency of said pivoting  
3 device and wherein said magnetic coil and said permanent magnet interact to create pivotal  
4 oscillations of said device at said selected sweep frequency.
- 1 17. The multilayered device of claim 16 wherein said selected sweep frequency is  
2 substantially equal, to the resonant pivoting frequency of said device.
- 1 18. The multilayered device of claim 5 wherein said back layer has a size and shape  
2 substantially matching said size and shape of said attaching member.
- 1 19. The multilayered device of claim 18 and further comprising piezoelectric material  
2 bonded to said support structure of said hinge layer to create resonant pivoting of said device  
3 about said first axis.
- 1 20. The multilayered device of claim 5 wherein said hinge layer is made from single crystal  
2 silicon.
- 1 21. The multilayered device of claim 20 wherein said front layer is made from single crystal  
2 silicon.
- 1 22. The multilayered device of claim 1 wherein said functional surface of said front layer is a  
2 mirror.
- 1 23. The multilayered device of claim 22 wherein said back layer is a permanent magnet.

1 24. The multilayered device of claim 23 and further comprising a magnetic coil connected to  
2 an alternating voltage having a frequency equal to a selected sweep frequency of said mirror  
3 functional surface and wherein said magnetic coil and said permanent magnet interact to create  
4 pivotal oscillations of said mirror at said selected sweep frequency.

1 25. The multilayered device of claim 24 wherein said selected sweep frequency is  
2 substantially equal to the resonant frequency of said mirror functional surface about said first  
3 axis.

1 26. The multilayered device of claim 25 used as a drive engine to provide a scanning beam.

1 27. The multilayered device of claim 26 wherein said drive engine provides the scanning  
2 beam for a printer.

1 28. The multilayered device of claim 22 wherein said back layer has a size and shape  
2 substantially matching said size and shape of said attaching member.

1 29. The multilayered device of claim 28 and further comprising piezoelectric material  
2 bonded to said support structure of said hinge layer to create resonant pivoting of said device.

1 30. The multilayered device of claim 29 used as the drive engine to provide a scanning beam.

1 31. The multilayered device of claim 5 wherein said functional surface of said front layer is a  
2 mirror.

1 32. The multilayered device of claim 31 and further comprising a magnetic coil connected to  
2 an alternating voltage having a frequency equal to a selected sweep frequency of said pivoting

3 device and wherein said magnetic coil and said permanent magnet interact to create pivotal  
4 oscillations of said device at said selected sweep frequency.

1 33. The multilayered device of claim 32 wherein said selected sweep frequency is  
2 substantially equal, to the resonant pivoting frequency of said device.

1 34. The multilayered device of claim 31 wherein said back layer has a size and shape  
2 substantially matching said size and shape of said attaching member.

1 35. The multilayered device of claim 34 and further comprising piezoelectric material  
2 bonded to said support structure of said hinge layer to create resonant pivoting of said device  
3 about said first axis.

1 36. The multilayered device of claim 31 wherein said hinge layer is made from single crystal  
2 silicon.

1 37. The multilayered device of claim 36 wherein said front layer is made from single crystal  
2 silicon.